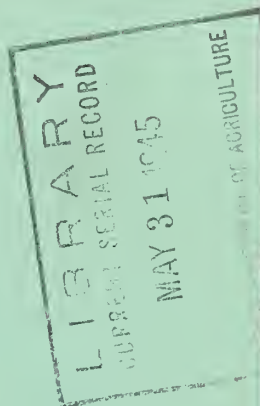**Historic, Archive Document**

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WOOD WASTE AVAILABLE FOR CONVERSION TO ETHYL ALCOHOL

IN THE COLUMBIA AREA OF SOUTH CAROLINA

by

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A FOREST SURVEY PROGRESS REPORT

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U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
In cooperation with
SOUTH CAROLINA STATE COMMISSION OF FORESTRY

Appalachian Forest Experiment Station
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PREFACE

Through the McSweeny-McNary Act of 1928, Congress authorized the Secretary of Agriculture to conduct a comprehensive survey of the forest resources of the United States. The Forest Survey was organized by the Forest Service to carry out the provisions of the Act, and each of the 11 Regional Forest Experiment Stations is responsible for the work in its territory. In the Middle Atlantic States the Forest Survey is an activity of the Appalachian Forest Experiment Station, Asheville, North Carolina.

The work of the Survey is divided into five major phases:

1. Inventory. Determination of the extent, location, and condition of forest lands, and the quantity, species, and quality of timber on these lands.

2. Growth. Determination of the current rate of timber growth.

3. Drain. Determination of the amount of industrial and domestic wood used, and the total loss resulting from fire, insects, disease, suppression, and other causes.

4. Requirements. Determination of the current and probable future requirements for forest products by all classes of consumers.

5. Policies and plans. Analysis of the relation of these findings to one another and to other economic factors as a basis for public and private policies and plans of forest land use and management.

This progress report summarizes information having a bearing upon the drain phase of the Survey, and deals specifically with the amount of wood waste produced in connection with lumber manufacture by sawmills and concentration yards in the Columbia area of South Carolina.

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*A limited number of this Release were issued as a Forest Survey Special Report on August 15, 1944.

SUMMARY

About 332,000 tons (oven-dry) of pine wood waste, including slabs, edgings, and sawdust from sawmills, and sawdust and shavings from concentration yards, are produced annually in the Columbia area of South Carolina. Of this amount, there is an unused surplus of about 188,000 tons which, if utilized for alcohol, would yield 9 million gallons.

About 56,000 tons of the waste available for alcohol are shavings produced by 37 concentration yards. Available waste from 298 sawmills amounts to 131,000 tons, of which 51,000 tons are slabs and edgings, and 80,000 tons are sawdust.

Assuming the construction of an alcohol plant of 3-million gallon capacity, 60,000 tons (oven-dry) of pine wood waste would be needed to supply the yearly requirements of raw material. The most logical procurement plan would require obtaining about 56,000 tons of shavings from concentration yards and 4,000 tons of sawdust from sawmills.

The shavings output of 14 yards, totaling 15,000 tons, could be transported to the plant by truck. About 41,000 tons would come by rail from 23 yards. All of the sawdust could be transported by truck from mills within a 20-mile radius of Columbia.

Based on prevailing rates, the total transportation cost is estimated at $108,000 annually. This amounts to $1.80 per ton or 3.6 cents per gallon of alcohol. Indications are that some reduction in rail rates is possible. This would reduce the total transportation cost by about $24,000 annually. Cost per ton (oven-dry) would then amount to only $1.40, which is the equivalent of 2.8 cents per gallon.

The concentration yards and sawmills of the Columbia area draw their pine timber from about 20 of the 46 counties in the state. In 1936, according to the Forest Survey, these counties contained about 6.6 billion board feet of pine sawtimber. In the 7-year period from January 1, 1936, to January 1, 1943, this pine stand has increased to about 6.8 billion feet, a net increase of nearly 4 percent.
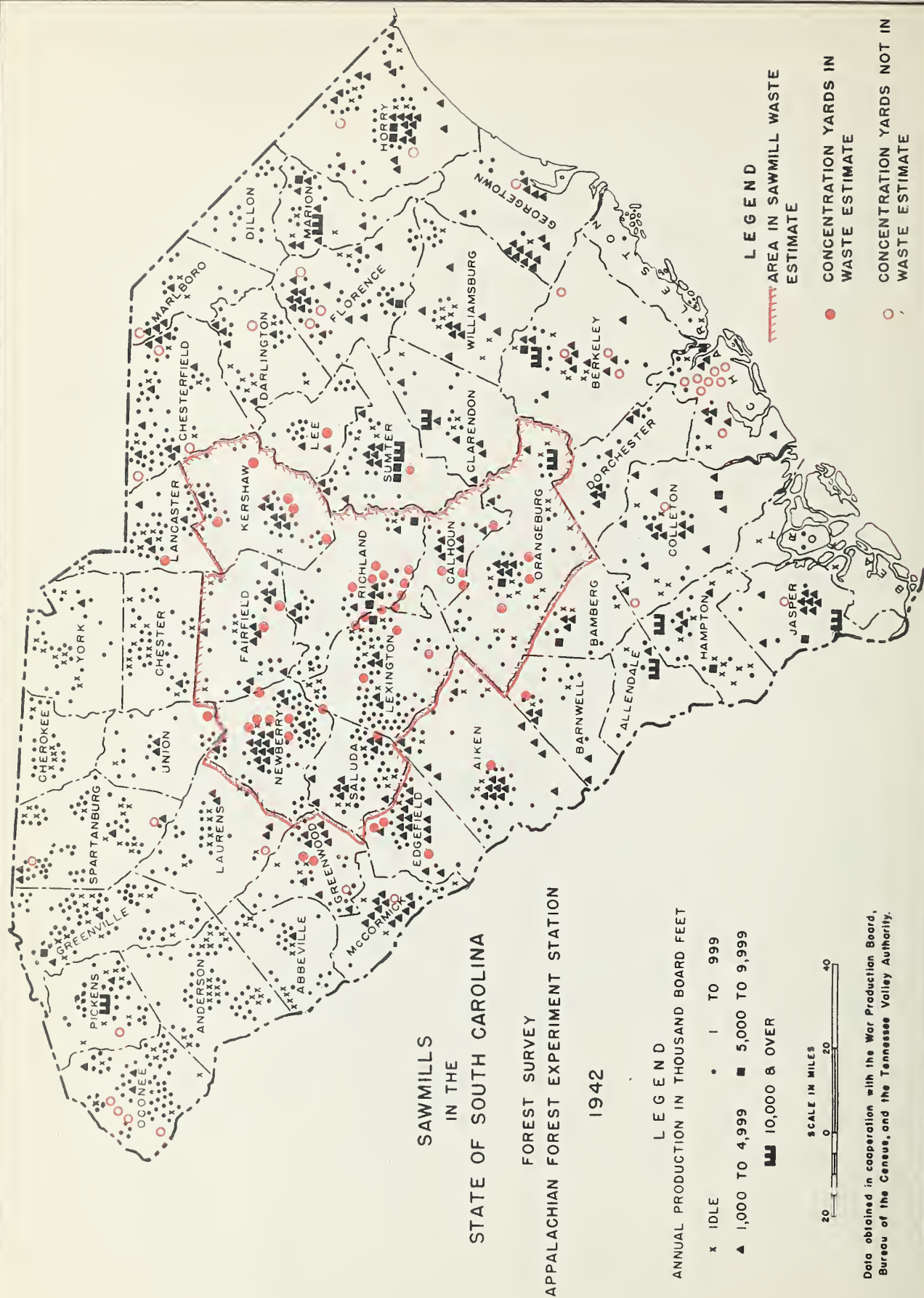
SAWMILLS
IN THE
STATE OF SOUTH CAROLINA

FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1942

LEGEND
ANNUAL PRODUCTION IN THOUSAND BOARD FEET

×   IDLE   •   1 TO 999

▲   1,000 TO 4,999   ■   5,000 TO 9,999

⊞   10,000 & OVER

SCALE IN MILES

20   0   20   40

Data obtained in cooperation with the War Production Board,
Bureau of the Census, and the Tennessee Valley Authority.

LEGEND

AREA IN SAWMILL WASTE ESTIMATE

CONCENTRATION YARDS IN WASTE ESTIMATE

CONCENTRATION YARDS NOT IN WASTE ESTIMATE

FIGURE 1

WOOD WASTE AVAILABLE FOR CONVERSION TO ETHYL ALCOHOL

IN THE COLUMBIA AREA OF SOUTH CAROLINA

THE PROBLEM

The efficient utilization of waste resulting from the manufacture of lumber has been a problem of long standing among lumbermen of South Carolina. Large volumes of sawdust, slabs, and edgings result from sawmill operations (figure 2). Huge quantities of shavings are produced at planing mills, but in the absence of a useful product to which this material can be converted they present a pressing problem of waste disposal (figures 4 and 5). At sawmills some relief is obtained as a result of local demands for domestic fuel. This takes care of part of the slab wood and edging production and yields some income (figure 3). The current shortage of pulpwood has also provided a market for a portion of the slab wood. Some sawmills and concentration yards also use all or part of their wood waste as boiler fuel. In spite of these and other outlets a major part of the total production of waste is just so much surplus material, and of benefit to no one.

Much of this surplus waste could be used in the manufacture of ethyl alcohol. As a consequence of German patents taken over by the U. S. Alien Property Custodian and their subsequent improvements by chemists of the U. S. Forest Service, a process for the rapid, economical conversion of wood waste to alcohol is now available. Pilot plant tests at Marquette, Michigan, have shown that a ton of waste (oven-dry) from softwoods, such as the southern yellow pine, will yield 50 to 60 gallons of alcohol. The yield from hardwood is about 30 to 40 gallons per ton. So far, only one alcohol plant of commercial size, located at Springfield, Oregon, is under construction. Its success will point the way to large-scale utilization of wood wastes elsewhere.

The purpose of this report is to present the quantity, location, and probable cost of transporting southern yellow pine wood waste, available for conversion to alcohol, in the Columbia area of South Carolina. Inasmuch as the future timber supply may have an important bearing on the location of an alcohol plant, that phase of the problem is presented also.

THE AREA

For the purpose of this report the area includes all concentration yards within an 80-mile rail haul of Columbia and all sawmills within an approximate 40-mile radius of the same city (figure 1).

The primary reason for selecting this area is that it contains many more concentration yards than comparable areas elsewhere in the state. These yards produce large volumes of shavings—free from foreign material and of a low moisture content—most of which are available for alcohol.

Furthermore, practically all yards are located on railroads, and shavings can be blown directly from the planer into box cars with a minimum outlay for equipment.

Another factor favoring the area is the large number of sawmills located therein. According to a field canvass made in 1942, in cooperation with the Bureau of the Census, 298 sawmills were operating within the area. Few, if any, other sections in the state have as many.

Of considerable importance are the excellent rail facilities available. The lines of four railroads, three of which are major roads, center on Columbia. As a consequence, with Columbia as the hub, rail lines radiate from there as nine spokes of a wheel. These facilities, supplemented by a network of good motor roads, greatly simplify transporting wood waste from all parts of the area.

SURVEY PROCEDURE

There are 47 concentration yards within the Columbia area. These plants assemble rough green lumber from portable mills, air or kiln dry it, and trim and plane it for the market. The largest volume of waste from these operations is in the form of shavings. "Blocks" resulting from trimming and sawdust from resawing are distinctly secondary items of waste. In cooperation with the South Carolina State Commission of Forestry, 42 yards were visited and information obtained as to the quantity of waste produced and the amount available from each. Additional information was obtained at the yards in regard to waste production and quantity available at associated sawmills; also, 18 independent sawmills were visited to obtain similar information. For the five concentration yards not visited, average values--as determined from the data obtained at the plants contacted--were applied.

WASTE AVAILABLE

Including slabs, edgings, and sawdust produced at sawmills and the sawdust and shavings at concentration yards, it is estimated that 331,600 tons, oven-dry weight, are produced annually.[1] Of this amount about 144,000 tons, 43 percent, are considered unavailable, being utilized as fuel for power, sold for domestic fuel or pulpwood, or used for other purposes. Available for alcohol, therefore, are approximately 187,600 tons of waste which, if fully utilized, is sufficient to manufacture over 9 million gallons of alcohol annually.

Waste from concentration yards: Table 1 shows, for the 47 concentration yards, the production of dressed pine lumber, the cubic feet of solid air-dry wood from the lumber in the form of shavings, the oven-dry

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[1]/Based on 1942 lumber production at sawmills, and estimated normal production at concentration yards.

Figure 2. - In the Columbia area over
200 portable mills produce wood waste
consisting of slabs, edgings, and saw-
dust.

Figure 3. - Accumulation of slabs and edgings at medium
size stationary mill. Material to be marketed as fuelwood.

Figure 4. - Three-year accumulation of sawdust and shavings
at concentration yard at Blaney.

Figure 5. - Thousands of tons of wood waste are disposed of by burning
in pits similar to the one used at the Stuckey Lumber Co. in Columbia.

weight of the shavings, and the probable alcohol yield. These data are presented for a normal or peacetime year as well as for 1943.

Table 1. – Summary of pine shavings production at 47 concentration yards in the Columbia area of South Carolina.

| Item | Unit | Number of units | |
		Normal	1943
Concentration yards	No.	47	47
Production of planed pine lumber	M bd.ft.	280,000	210,000
Air-dry wood converted to shavings	Cu. ft.	6,240,000	4,564,000
Used at yards	"	2,965,000	1,948,000
Available for alcohol	"	3,275,000	2,616,000
Oven-dry weight of shavings	Tons	107,000	78,300
Used at yards	"	50,600	33,400
Available for alcohol	"	56,400	44,900
Probable alcohol yield	Gals.	2,820,000	2,245,000

If all surplus shavings from concentration yards are collected and utilized for alcohol, approximately 2.25 million gallons could be manufactured annually from current reduced wartime production and 2.8 million gallons from the output of a normal year.

Only shavings were included as an item of available waste from concentration yards. Practically all yards visited had developed a fuel-wood market for the "blocks" or short pieces of boards resulting from trimming lumber to market sizes. Consequently this class of material was excluded from the estimate. Sawdust accumulating from resawing operations is largely accounted for in the waste estimate for shavings and is included as such.

Ten of the 47 yards used all of their shavings for generating power or for operating dry kilns. None had a cash market for shavings, but of the 37 yards having a surplus, 12 were giving away at least part of their production. The recipients of these "free" shavings are chiefly local plants such as laundries which use this material for power.

The majority, or 36, of the plants were steam powered. Of the remainder, 7 were operated by electricity, 2 with power units, and 2 by a combination of steam and electricity. It should be noted that a partial canvass of the steam-powered plants revealed that about 40 percent would probably convert to electric or Diesel power if a cash market for shavings were available. This indicates a possible increase of about 20,000 tons, oven-dry weight, in the amount of shavings available for alcohol in a normal year.

Waste from sawmills: In table 2 is presented the estimated amount
of waste produced by all sawmills in the area and the quantity of this
material that might be available for alcohol. The range in sawmill waste

Table 2. - Estimated quantity of pine waste from sawmills in the
Columbia area of South Carolina.

County	No. mills	1942 pine lumber pro- duction	Estimated quantity of waste produced	Estimated quantity of waste available		
				Sawdust	Slabs & edgings	Total
		M bd.ft.	Tons[1]	Tons[1]	Tons[1]	Tons[1]
Calhoun	11	10,300	11,500	4,100	2,600	6,700
Fairfield	31	23,500	26,400	9,400	6,000	15,400
Kershaw	35	26,200	29,400	10,500	6,700	17,200
Lexington	59	26,200	29,400	10,500	6,700	17,200
Newberry	57	37,500	42,100	15,000	9,600	24,600
Orangeburg	38	31,000	34,800	12,400	7,900	20,300
Richland	34	22,800	25,600	9,100	5,800	14,900
Saluda	33	22,600	25,400	9,100	5,800	14,900
Total	298	200,100	224,600	80,100	51,100	131,200

[1]/Oven-dry weight.

production is very wide inasmuch as the smallest mills produce only a few
thousand board feet annually as compared with 15 million or more board
feet sawed by the large mills. Small mills are typical of the area, av-
eraging about 500 thousand board feet per year. According to the 1942
census of lumber production, only 5 mills produce over 5 million board
feet annually.

The difference of 93,400 tons, oven-dry weight, between the amount
of waste produced and available is principally the result of a fairly
good market for slabs and edgings as domestic fuel. Some slabwood is also
sold as pulpwood by small mills. Large mills use practically all of this
material for power. The 51,100 tons of slabs and edgings shown as being
available are chiefly those from the portable mills located in the more
remote areas or those produced in the summer when the demand for fuelwood
is comparatively low.

One of the principal obstacles toward the full utilization of slabs
and edgings for alcohol is that the majority of mills do not have a hog or
sufficient power to operate one. Consequently, a piece by piece handling
of slabs and edgings in loading and unloading from a railroad car or truck
would probably result in excessive procurement costs. On the other hand,
when ground by means of a hog the slabs and edgings would be in suitable
form for the digesters of an alcohol plant, and also in a condition to be
loaded and unloaded cheaply by mechanical methods. Few mill operators
could stand the expense of a hog and an additional power unit at the

probable price paid for wood waste. In view of the above it is believed that slabs and edgings should be considered only as a supplement to more readily available types of wood waste.

The situation is different with respect to sawdust as practically all of it is available and amounts to about 80,000 tons annually. Very little is used for power or hauled away for other purposes. The principal difficulties associated with the procurement of sawdust would be its collection and transportation. A large part of the sawdust would be obtained from portable mills which average about 90 thousand board feet per "set" and make about 7 of these "sets" per year. This means that the average sawdust pile contains about 40 tons, oven-dry weight, of raw material and the average portable mill produces 280 tons of sawdust annually. Obviously, the transportation of sawdust to an alcohol plant would be principally by truck. By means of portable mechanical loaders, such as are used for loading coal or gravel, it is believed that loading sawdust on trucks would be a simple matter. Furthermore, a network of good roads over the area makes all but the most remote portable mills accessible to Columbia.

TRANSPORTATION COSTS

A primary factor determining the feasibility of an alcohol plant is the cost of transporting wood waste. For the purpose of presenting transportation costs, a plant of 3 million gallons annual capacity is assumed. Such a plant would require approximately 60,000 tons, oven-dry weight, of pine wood waste annually. Shipping weights will exceed this tonnage because of the moisture content of the raw material.

From concentration yards: Thirty-one of the yards with available wood waste are located on railroads, and 6 are without rail facilities. However, 8 of the yards accessible by railroad are so near the proposed plant location that truck hauling appears more economical. Consequently, trucking costs are based on 14 yards (figure 6), while rail transportation costs are calculated for 23 (figure 7).

In a normal year about 16,300 tons of shavings could be hauled by truck (table 3). This is the equivalent of 14,900 tons, oven-dry weight, of shavings which will yield about 745,000 gallons of alcohol. The average transportation cost of 1.3 cents per gallon includes a range from 0.9 cents for those yards located in Columbia to 6.8 cents for the most distant yard, 43 miles away. The computed costs assume rapid loading from overhead bins at the yards, and unloading at the plant by mechanical means. An average truck load is estimated to be 5 tons, which can easily be hauled by a 1½ to 2 ton truck equipped with a semi-trailer. Per mile truck costs used are those established by the U. S. Forest Service for vehicles of the described type. These rates are believed to approximate those of local commercial truckers.
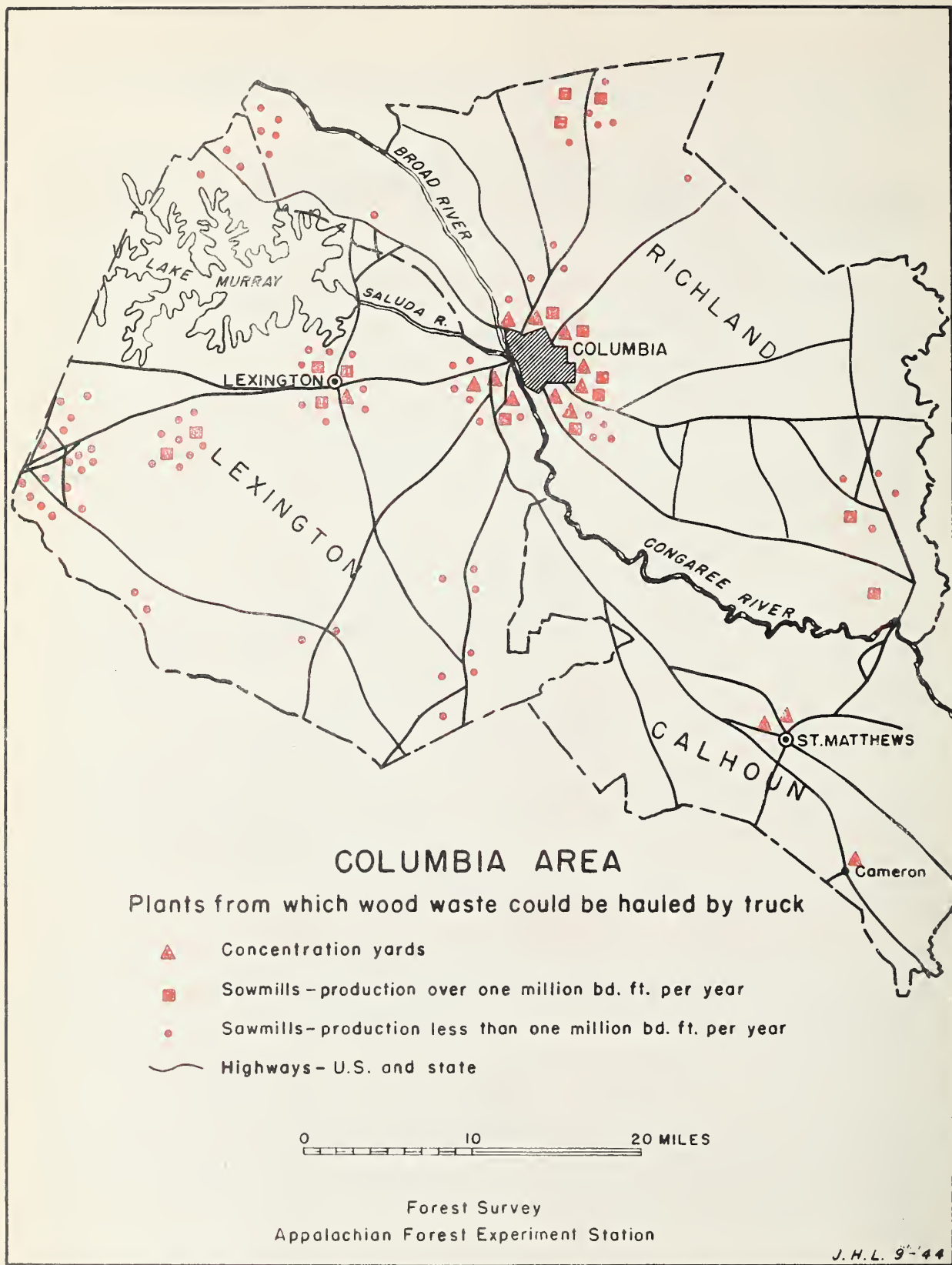
COLUMBIA AREA

Plants from which wood waste could be hauled by truck

△ Concentration yards

▣ Sowmills – production over one million bd. ft. per year

• Sawmills – production less than one million bd. ft. per year

⌒ Highways – U.S. and state

0   10   20 MILES

Forest Survey
Appalachian Forest Experiment Station

J.H.L. 9'–44

FIGURE 6

Table 3. - Estimated truck transportation cost of shavings from 14 concentration yards in the Columbia area of South Carolina.

Yard location	Distance from Columbia	Est. quantity of shavings available in a normal year		Possible alcohol prod.	Truck transportation cost		
		Air-dry weight[1]	Oven-dry weight[1]		Total	Per oven-dry ton	Per gal. of alcohol
	Miles	Tons	Tons	Gals.	Dollars	Dollars	Cents
Cameron	43	600	600	30,000	2,046	3.41	6.8
Lexington	12	300	300	15,000	303	1.01	2.0
St.Matthews " "	35	100	100	5,000	263	2.63	5.3
Columbia " " " " " "	3	10,200	9,200	460,000	4,284	0.47	0.9
W.Columbia " "	5	5,100	4,700	235,000	2,703	0.58	1.2
Total	-	16,300	14,900	745,000	9,599	0.64	1.3

1/To nearest hundred tons.

In a normal year the 23 yards, which would ship by rail, can deliver 46,500 tons of shavings. This is equal to 41,500 tons, oven-dry weight, and sufficient to manufacture about 2.1 million gallons of alcohol. Table 4 shows the shipping points and estimated quantity of shavings which may be transported in a normal year, or currently, as indicated by the 1943 tonnage.

According to representatives of a major railroad servicing the area, prevailing rates on the movement of shavings or sawdust are the same as for lumber. These are based on a minimum carload weight of 34,000 pounds. Shipping mileage is on a class rate grouping basis. Table 5 presents the estimated cost of rail transportation based on these rates. It should be noted that separate costs are shown for ground or baled shavings and for loose shavings. Baled shavings or those ground with a hammer mill will weigh 34,000 pounds, or more per carload, whereas loose shavings, blown from the planer directly into a box car, will weigh about 25,000 pounds. Consequently, under prevailing rail rates the movement of loose shavings by rail is more costly.
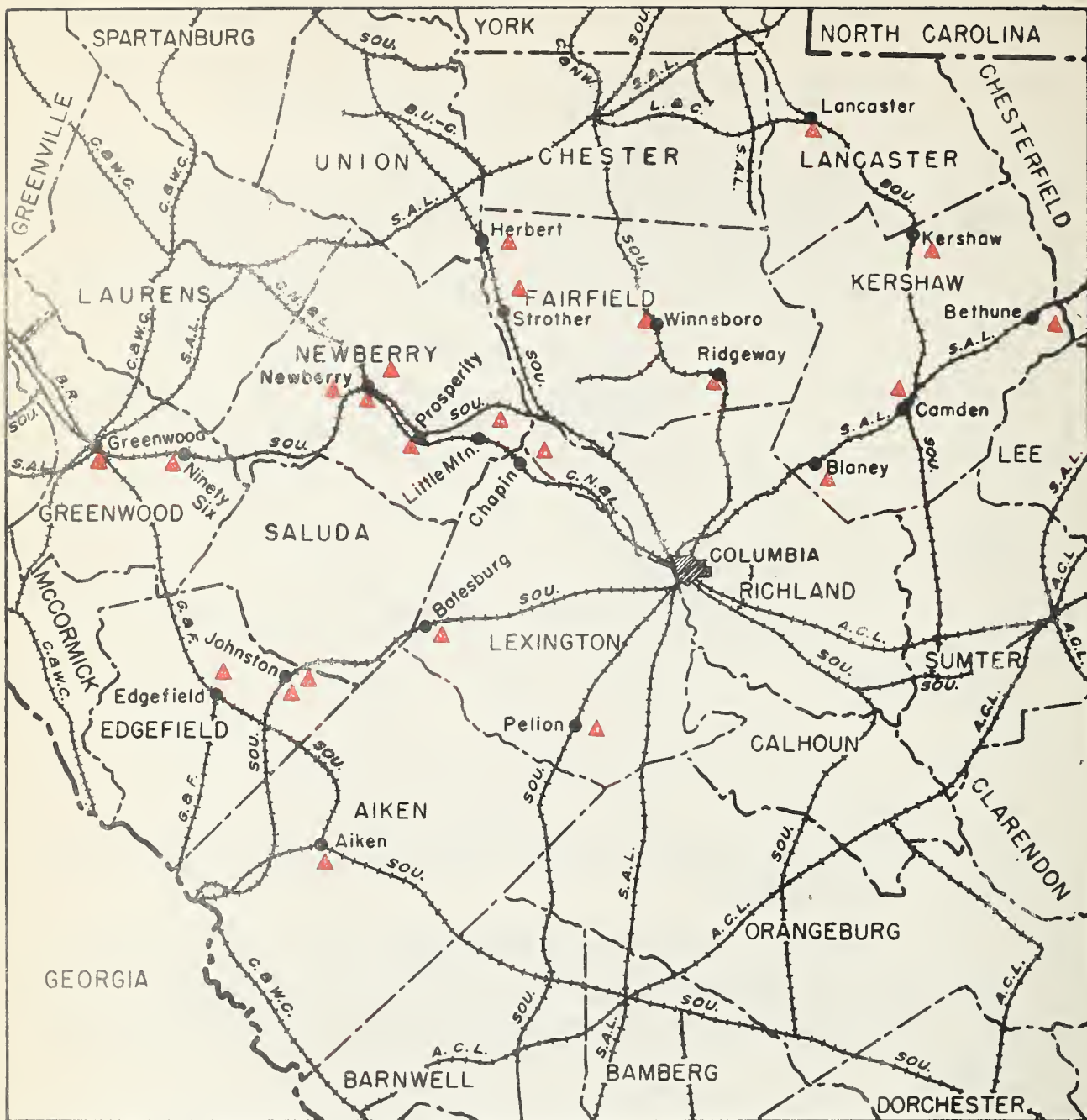
COLUMBIA AREA

Concentration yards located on railroads,
producing shavings available for alcohol.

🔺   Concentration yards

●   Shipping points

〰️   Railroads

SCALE IN MILES
0   10   20   30

FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION

FIGURE 7

Table 4. - Railroad shipping points and estimated tonnage
of shavings available annually from 23 concentration
yards in the Columbia area of South Carolina.

Shipping distance	Shipping point	Yards	Quantity of shavings[1]	
			1943	Normal
Miles		No.	Tons	Tons
31 to 40	Batesburg	1	1,400	1,000
	Blaney	1	900	700
	Camden	1	3,100	2,700
	Johnston	2	7,400	7,300
	Pelion	1	2,500	1,500
	Ridgeway	1	2,100	1,700
	Winnsboro	1	2,100	2,100
	Total	8	19,500	17,000
41 to 50	Chapin	1	400	300
	Little Mountain	1	2,400	2,400
	Newberry	3	6,000	5,600
	Prosperity	1	1,400	1,100
	Total	6	10,200	9,400
51 to 60	Bethune	1	100	100
	Herbert	1	1,700	1,300
	Strother	1	3,800	3,100
	Total	3	5,600	4,500
61 to 70	Edgefield	1	2,200	1,900
71 to 80	Aiken	1	1,600	1,300
	Greenwood	1	1,600	1,300
	Kershaw	1	2,400	2,300
	Lancaster	1	1,700	1,300
	Ninety-six	1	1,700	1,400
	Total	5	9,000	7,600
Total all points		23	46,500	40,400

[1]/Based on air-dry condition of shavings.

It is quite possible that the price paid to concentration yards
for shavings may not be enough to justify the operators' expenditure of
additional funds for grinding or baling equipment. The best solution
appears to be the establishment of a lower minimum carload weight (25,000
pounds) for sawdust and shavings on intrastate shipments. This would en-
able the transportation of loose shavings at the present cost of shipping
baled or ground material. Discussion with railroad officials indicates
that such an adjustment, or one yielding similar results, may be possible.

Table 5. - Estimated rail transportation costs of shavings produced in a normal year from 23 concentration yards within indicated rail distances from Columbia, South Carolina.

Yards No.	Rail dist. Miles	Est. quantity of shavings available annually		Possible alcohol production	Rail transportation cost					
		Air-dry weight Tons	Oven-dry weight Tons	Gallons	Ground or baled shavings			Loose shavings		
					Total Dollars	Per oven-dry ton Dollars	Per gal. of alcohol Cents	Total Dollars	Per oven-dry ton Dollars	Per gal. of alcohol Cents
8	40	19,500	17,400	870,000	25,350	1.46	2.9	34,476	1.98	4.0
14	50	29,700	26,500	1,325,000	39,630	1.50	3.0	53,897	2.03	4.1
17	60	35,300	31,500	1,575,000	48,030	1.52	3.0	65,321	2.07	4.1
18	70	37,500	33,500	1,675,000	51,550	1.54	3.1	70,108	2.09	4.2
23	80	46,500	41,500	2,075,000	66,850	1.61	3.2	90,916	2.19	4.4

The total annual cost of transporting available shavings, in-
cluding rail and truck haul, and assuming all material is shipped loose
under prevailing transportation rates, is $100,515 annually. This is
equivalent to a cost of $1.78 per ton, oven-dry weight, or 3.6 cents per
gallon of alcohol. An adjustment in rail rates, as suggested, would
lower total cost to $76,400, per ton oven-dry to $1.36, and per gallon
cost to 2.7 cents.

From sawmills: The supply of raw material from concentration
yards falls short of the requirements of a 3-million gallon alcohol
plant by about 3,600 tons, oven-dry weight. Within an approximate 20-
mile radius of Columbia, there are about 100 sawmills which annually
produce 45,000 tons, oven-dry weight, of wood waste (figure 6). Of
this amount 19,600 tons consist of available sawdust, from which the
600 tons of needed material can easily be obtained.

Sawdust from sawmills is largely in a green condition. Thus, the
procurement of 3,600 tons, oven-dry weight, will involve the transpor-
tation of about 6,000 tons of green sawdust. Assuming that all this
material is to be hauled by truck the total cost is estimated at $7,320
which is the equivalent of $2.04 per ton, oven-dry weight, or 4.1 cents
per gallon of alcohol. These estimates are based on average loads of
5 tons and a hauling distance of 15 miles. Rates used are taken from a
schedule of standard operation, repair, and depreciation for motor
vehicles prepared by the U. S. Forest Service.

From all sources: It may be seen from the preceding discussion
that the transportation of raw material for a 3-million gallon alcohol
plant in the Columbia area requires both rail and truck facilities.
The total annual cost of transporting the required amount of wood waste
is $107,835. This is equal to $1.80 per ton, oven-dry weight, or 3.6
cents per gallon of alcohol (table 6). However, if an adjustment in

Table 6. -- Estimated transportation costs of wood waste to supply an al-
cohol plant of 3-million gallon annual capacity in Columbia area of S. C.

Source of waste	Trans-portation method	Shipping weight	Oven-dry weight	Possible alcohol yield	Transportation cost	
					Per ton oven-dry	Per gal. of alcohol
		Tons	Tons	Gals.	Dollars	Cents
Conc. yards	Railroad	46,500	[1]41,500	2,075,000	[3]2.19	[3]4.4
Conc. yards	Truck	16,300	[1]14,900	745,000	0.64	1.3
Sawmills	Truck	6,000	[2]3,600	180,000	2.04	4.1
All sources	-	68,800	60,000	3,000,000	1.80	3.6

[1]Based on a normal output.
[2]Based on 1942 lumber production.
[3]Based on prevailing rail rates.

rail rates were made, the annual expenditur for transportation would
be reduced by about $24,000. Cost per ton, oven-dry, would then amount
to only $1.40, which is the equivalent of 2.8 cents for each gallon of
alcohol produced.

TIMBER SUPPLY

The concentration yards and sawmills of the Columbia area draw
their pine timber from about 20 of the 46 counties in the state. In
1936, according to the Forest Survey, these counties contained about
6.6 billion board feet of pine sawtimber. In the 7-year period from
January 1, 1936, to January 1, 1943, this pine stand has increased to
about 6.8 billion feet, a net increase of nearly 4 percent.

It would appear, therefore, that there is an assured timber
supply, particularly if progress is continued in fire protection and
the development of improved forest management practices. The need for
intensification of these practices is emphasized by the relationship
between timber growth and amount cut that has developed in South Carolina
as a result of heavy wartime cutting and the expansion of the pulp in-
dustry since 1936. In 1936 the net growth of pine sawtimber in the
entire state exceeded drain by 16 percent whereas in 1942 drain exceeded
growth by 27 percent. In the Columbia area the situation is more favor-
able, because nearly one-half of it is located in the Piedmont where
growth of pine sawtimber still exceeded drain in 1942.